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INSTRUCTION MANUAL

TYPE 1160-P2

SWEEP AND MARKER GENERATOR

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GENERAL RADIO COMPANY

West Concord, Massachusetts

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SPECIFICATIONS

AUTOMATIC SWEEP

Sweep Voltages: Symmetrical triangular waveforms centered on 0 V dc.

Time for One-Way Sweep: 0.02 s to 60 s, automatic, selectable in 9 steps.

Sweep-Time Accuracy: ±10%.

Outputs: CAD sweep is continuously adjustable from ±1 to ±10 major CAD divisions (±0.3 to ±3 V approx). The SCOPE HORIZ output is nonadjustable (12 V, p-to-p, behind approx 10 kΩ).

MANUAL SWEEP

Outputs: Sweep excursions are the same as in automatic mode, with continuous manual control.

MARKERS

Location: Center marker occurs at the frequency set on synthesizer digit dials. Side markers are displaced symmetrically from the center marker by the amount set on the MARKER SPACING dials.

Side Marker: Spacing from center marker can be from 1.0 to 5.9 CAD divisions in 0.1 steps. **Accuracy:** ±1% of dial setting.

GENERAL

Power Required: 100 to 125 or 200 to 250 V, 50 to 400 Hz, 3 W.

Ambient Temperature: 0 to 50°C.

Accessories Supplied: Two 2-foot and two 4-foot BNC coaxial patch cords, CAP-22 3-wire power cord, spare fuse.

Terminals: Connections to synthesizer, MARKER OUT, and SCOPE HORIZ output available front and rear.

Cabinet: Rack-bench. End frames for bench mount and fittings for rack mount are included.

Dimensions (width x height x depth): Bench, 19 x 2 x 14½ in (485 x 52 x 370 mm); rack, 19 x 1¾ x 13¼ in (485 x 43 x 330 mm).

Weight: Net, 12 lb (5.5 kg); **shipping,** 16 lb (7.5 kg).

SECTION 1

INTRODUCTION

1.1 PURPOSE.

The Type 1160-P2 Sweep and Marker Generator is an accessory for General Radio synthesizers that provides a means of varying the output frequency of CAD-equipped units at a controlled known rate. In addition, precision markers are provided for use in monitoring the frequencies being generated. Incorporated are such features as a variable-speed automatic sweep control and a means of changing the spacing of frequency-monitoring markers.

A synthesizer augmented by the sweeper can be used for frequency-response testing of active and passive networks and frequency-selective instruments. The combination offers:

1. a wide choice of automatic sweep speeds
2. a triangular-wave output, synchronized with the sweep for driving the horizontal axis of an oscilloscope or other indicating device.
3. a calibrated center-frequency marker
4. step-wise adjustable side markers
5. a convenient means of expanding the sweep coverage about any synthesized center frequency, continuously and in decade steps.

All GR synthesizers can be equipped with the Continuously Adjustable Decade (CAD) Module. As explained in the synthesizer instruction manuals, this module can be electrically substituted for step-digit modules, from the smallest step up to the X100-kHz station, by pushbutton selections. Each synthesizer contains built-in monitor circuits that permit calibration of the CAD module against that portion of the total dialed frequency represented by the displaced digit modules. If the CAD frequency is caused to depart from the frequency generated by the replaced step-digit units, the difference frequency appears at the BEAT terminals. This beat frequency is used to generate frequency markers, as explained below.

The CAD frequency can be varied by an external control voltage in a known manner (approximately 0.3 V per major CAD division) around any frequency set by its dial. The continuous monitoring of the beat frequency, between the CAD output and the frequency generated by the step-digit modules that the CAD has replaced, permits an accurately defined center-frequency marker to be generated when this beat is zero. The beat frequency, used in conjunction with an external reference frequency, also permits generation of accurate side markers, indicating known deviations from center frequency. Both the sweeping voltage and marker reference frequencies are supplied by the Type 1160-P2.

1.2 DESCRIPTION.

The Type 1160-P2 Sweep and Marker Generator furnishes a triangular sweep voltage for application to the EXTERNAL CAD CONTROL of the synthesizer. The amplitude of this waveform is adjustable by the FREQUENCY EXCURSION control. A corresponding (and non-adjustable) sweep voltage is available to drive the horizontal-deflection amplifier of an oscilloscope or an X-Y recorder. Nine automatic (one-way) sweep times, ranging from 60 seconds to 20 milliseconds, are available, as well as a manual sweep control.

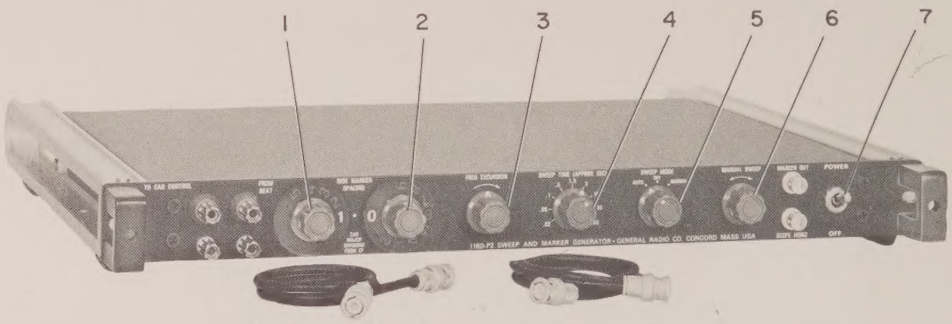


Figure 1-1. Type 1160-P2 Sweep and Marker Generator. Refer to Tables 1-1 and 1-2 for details on controls and connectors. Patch cords in the foreground are representative of units supplied.

Since both sweeps have the same shape, the retrace should follow exactly the initial sweep, provided that the sweep is not too fast for the device under test. Thus, a multiple-trace response is a convenient indication that an inappropriate (too fast) sweep rate is being used.

An internal variable oscillator furnishes a reference to generate side-marker voltages on a storage scope or other device used for display or recording. The center frequency marker occurs when the synthesizer output frequency is exactly that which has been set on all the digit dials. The side markers are positioned at symmetrical spacings above and below the center frequency, and the spacing is adjustable by two digit dials that read in divisions and tenths of divisions of the CAD dial. Since one CAD dial division can correspond to output-frequency changes ranging (in decade steps, i.e., 0.001, 0.01, 0.1, 1, 10, 100, etc.) from 0.001 Hz to 100 kHz, as chosen by pushbutton on the synthesizer, the system offers a wide choice of sweep widths, sweep rates, and marker spacings.

Side markers cannot be positioned closer than 1 CAD division to the center marker. However, CAD sweep linearity, below 1 division, is such that linearly spaced oscilloscope-graticule markings can be used to subdivide this close-in frequency region with great accuracy.

1.3 CONTROLS AND CONNECTORS.

The controls on the Type 1160-P2 Sweep and Marker Generator (Figure 1-1) are listed in Table 1-1; the connectors on the front and rear panels of the instrument are listed in Table 1-2.

1.4 ACCESSORIES SUPPLIED.

Table 1-3 lists accessory equipment supplied to facilitate connection to and use with GR synthesizers.

TABLE 1-1

TYPE 1160-P2 FRONT PANEL CONTROLS

Fig. 1-1 Ref.	*Name*	*Type*	*Function*
1	SIDE MARKER SPACING	Rotary switch, 5-position (1-5)	Sets spacing in unit steps of CAD major divisions.
2	SIDE MARKER SPACING	Rotary switch, 10-position (0-9)	Sets spacing in tenths of unit steps of CAD major divisions.
3	FREQUENCY EXCURSION	Continuously adjustable potentiometer	Controls the amplitude of sweep voltage applied to CAD. ("SCOPE HORIZ" sweep voltage is not affected.)
4	SWEEP TIME	Rotary switch, 9-position	Sets automatic-sweep rates in seconds.
5	SWEEP MODE	Rotary switch, 3-position	Selects AUTOmatic or MANUAL sweep operation, or zero sweep output for calibration purposes at OFF.
6	MANUAL SWEEP	Continuously adjustable potentiometer	Provides for operator control of sweep voltages proportional to knob rotation (positive or negative from zero).
7	POWER	Toggle switch, DPST	Line-voltage control.

TABLE 1-2
CONNECTORS

Name	*Front Panel*	*Rear Panel*	*Function*
TO CAD CONTROL	Binding Post	BNC Coaxial	Output terminal for CAD sweep voltage.
FROM BEAT	Binding Post	BNC Coaxial	Terminal for injection of BEAT signal from synthesizer.
MARKER OUT	BNC Coaxial	BNC Coaxial	Connector for center-frequency and side-marker output signals.
SCOPE HORIZ	BNC Coaxial	BNC Coaxial	Output connector for scope sweep voltage.

TABLE 1-3
ACCESSORIES SUPPLIED

Item	*Function*	*Part Number*
Line cord, 3-wire, 7 ft	Attaches to PL501 on rear apron.	4200-9622
Fuse, 0.062A	Spare line fuse.	5330-0300
Patch Cords, 4 ft, BNC-to-BNC, 2 each	Interconnection of appropriate front-panel BNC connectors on sweeper to oscilloscope.	1160-3021
Patch Cords, 2 ft, BNC-to-BNC, 2 each	Interconnection of rear-apron BNC connectors of sweeper and synthesizer.	1160-3020
End-Frame Set, aluminum, with attaching hardware	Attaches to unit to permit bench mounting with synthesizer.	5310-9612
Screw, 10-32 Phillips head	Attaches end frame to front panel, or attaches unit to rack.	7270-6210

SECTION 2

INSTALLATION

2.1 GENERAL.

As supplied, the Type 1160-P2 sweeper can be operated on the bench or mounted in a relay rack.

2.2 BENCH USE.

The Type 1160-P2 sweeper can be stacked with its associated synthesizer for bench use. It can be mounted either atop or underneath the synthesizer, with the panels in line and with the rubber feet, on the end frames of the upper unit, nestled in the groove on the upper surface of the end frames on the companion unit. Clearance holes for No. 10-32 machine screws in the centers of the end frames permit the instruments to be bolted together, if required (Figure 2-1).

Electrical interconnection between matching connector pairs on the instruments can be achieved with the shorter pair of BNC-plug-terminated patch cords supplied. Use of the rear-apron connectors, as shown

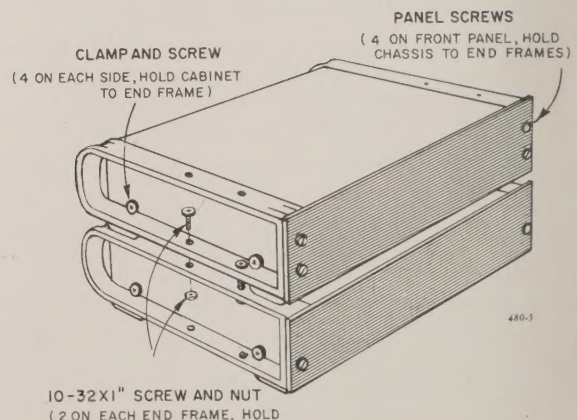

PANEL SCREWS
(4 ON FRONT PANEL, HOLD CHASSIS TO END FRAMES)
CLAMP AND SCREW
(4 ON EACH SIDE, HOLD CABINET TO END FRAME)
480-5
10-32X1" SCREW AND NUT
(2 ON EACH END FRAME, HOLD END FRAMES TOGETHER)

Figure 2-1. Preparation of the Type 1160-P2 for bench use with a synthesizer.

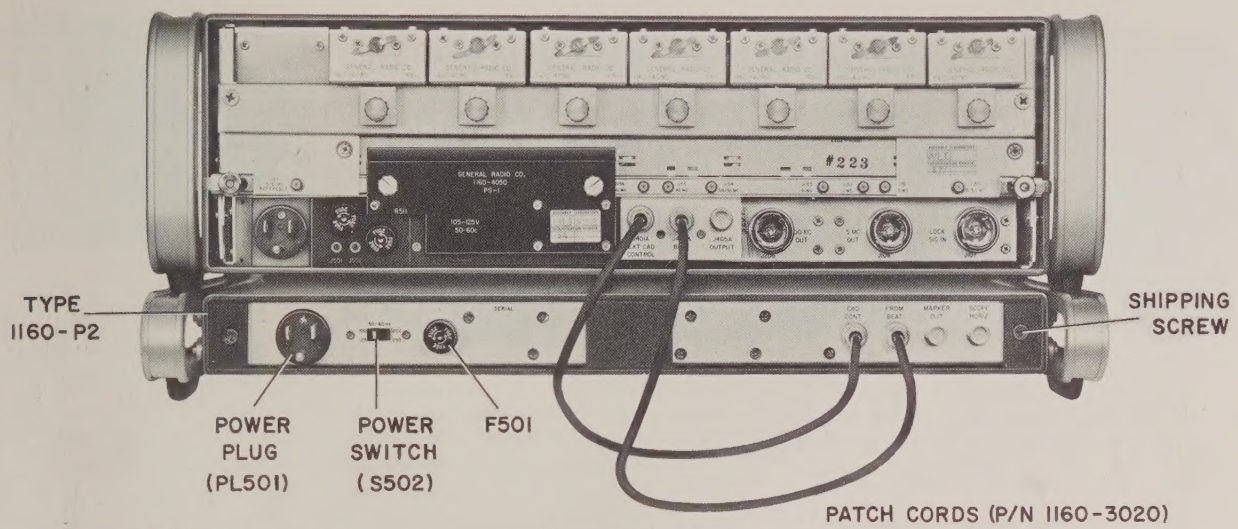


Figure 2-2. Rear view of a synthesizer/sweeper combination for bench use showing interconnecting patch cords installed.

in Figure 2-2, is recommended, but corresponding connections can be made to the front panel terminals, if desired.

2.3 RACK MOUNT.

The Type 1160-P2 sweeper can be rack mounted, either above or below the synthesizer with which it is to be used, or at a more remote location. For rack mounting, the end frames must first be removed and the front-panel screws (accessible through the handles), used to secure the unit to the rack (Figure 2-1). The front-panel mounting holes on sweeper and synthesizer are so spaced that they will correspond to the standard EIA rack-rail interval, with meeting edges on their front panels touching. Over-all dimensions of the sweeper are shown in Figure 2-3.

2.4 POWER.

The Type 1160-P2 sweeper can be operated on ac-line inputs ranging from 100 to 125, or from 200 to 250 volts. Insert the tip of a screwdriver blade in the white marker and use it to position the rear-apron slide switch at the appropriate setting. Connect the three-wire power cord (supplied) between the rear-apron plug and the ac-line source.

2.5 OTHER CONNECTIONS.

Use the longer pair of BNC-plug terminated patch cords supplied to connect the MARKER OUT jack to a vertical input of the oscilloscope, or recorder, and the SCOPE HORIZ jack to the horizontal input; see Figure 4-1. These jacks are duplicated front and rear.

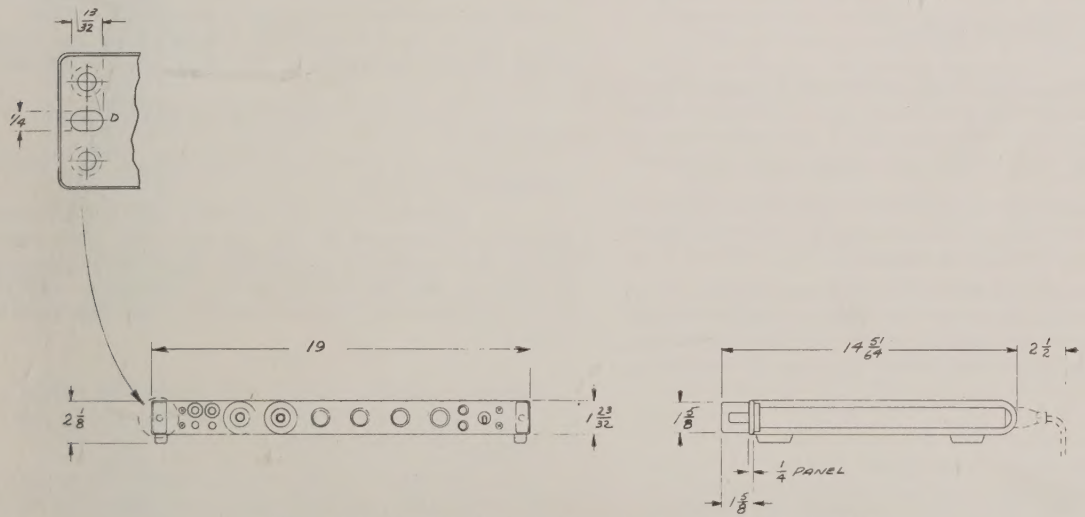


Figure 2-3. Over-all clearance dimensions for the Type 1160-P2 Sweeper.

SECTION 3

OPERATING PROCEDURE

3.1 POWER TURN ON.

Connect the Type 1160-P2 Sweep and Marker Generator to a source of power corresponding to the setting of the slide switch at the rear of the instrument. Turn the front-panel POWER switch on (up).

3.2 DISPLAY CONNECTIONS.

The interconnections between the Type 1160-P2 Sweep and Marker Generator and the synthesizer (EXTERNAL CAD CONTROL and BEAT terminals) can be made at either the front or rear of both units as follows:

a. Connect the MARKER OUT terminal (BNC) to one vertical-deflection input of the display device, which desirably should have two channels.

b. Connect the SCOPE HORIZontal output (±6 V) to the horizontal input of the display device. Visual sweep width can be established by the horizontal gain control of the scope, or other display or recording device.

NOTE

Storage-type oscilloscopes are recommended for use with the sweeper/synthesizer combination.

3.3 SWEEP-MEASUREMENT PROCEDURE.

The following procedure should be used:

a. Connect the device to be evaluated to the output of the synthesizer. Connect a suitable detector to the device output and connect the output of the detector to the second vertical input of the oscilloscope. Adjust appropriate levels for convenient display.

b. Set the synthesizer step digits to the anticipated center frequency of the device to be frequency swept.

c. Place the SWEEP MODE switch in the OFF position.

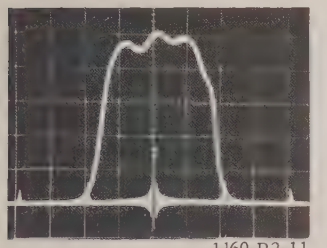
d. Set the CAD mode switch in the EXTERNAL CONTROL position.

e. Depress the appropriate DI-replacement-selector pushbutton on the synthesizer. This establishes the maximum bandwidth about the center frequency that the CAD can be swept; it should be selected in accordance with the bandwidth of the device being tested.

NOTE

If the bandwidth is unknown, choice of a wide frequency sweep will ensure location of the response on the display.

f. Rotate the CAD dial for approximate agreement with the pushbutton-replaced step digits. Set the synthesizer MONITOR switch to CAD CAL and adjust the CAD dial for a zero beat on the MONITOR meter.



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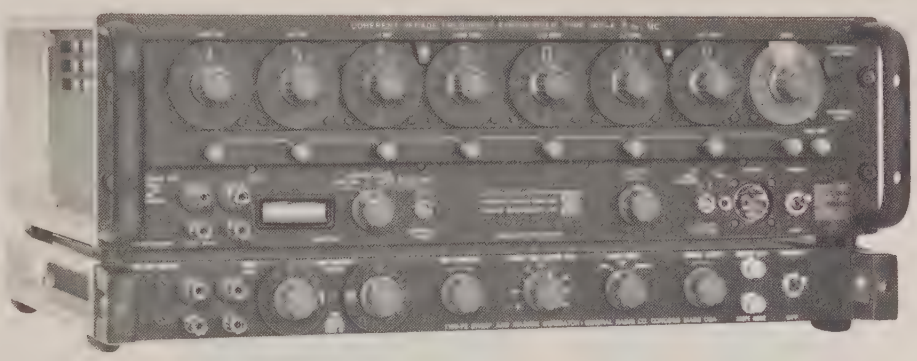


Figure 3-1. Type 1160-P2 with Type 1162-A7C. Controls set to sweep a 455-kHz filter with a 1.5-kHz bandwidth. In the resulting oscillogram, the horizontal scale is 500 Hz/cm, as shown by the ±1 kHz marks. The CAD was in the X1-kHz position and was swept ±2½ major divisions, or 2.5 kHz.

g. Center the dot on the CRT display and look for it to jump rapidly up and down as agreement between the CAD and replaced digit dials is approached, then slow down at zero beat. This bipolar center marker will not shift position if the FREQ EXCURSION control is subsequently used to adjust the amount of sweep, when calibrated as described.

h. Move the sweep generator SWEEP MODE control to AUTO. A continuous display of device response and marker output should result. The markers are from 0.1 to 0.2 V in amplitude, as supplied to the oscilloscope, and may be adjusted to a convenient amplitude on the display by use of the vertical gain controls.

i. In the event that the device display is not centered on the bipolar zero-beat marker, a more judicious choice of synthesizer center frequency should be made. Or, where applicable, the device should be readjusted to bring its center frequency to the synthesizer center frequency.

NOTE

Side-markers deteriorate in amplitude at sweep speeds above one per second; the center marker is observable at all speeds. Side-marker harmonics produce smaller additional markers, at twice and three times the selected spacing. The primary markers are the larger ones nearest the center marker.

j. Adjust side-marker spacing, in units and tenths, to establish desired bandwidth checkpoints, or to ascertain the frequency of a specific device response.

NOTE

The center-marker always occurs when the *synthesizer* frequency exactly equals the frequency set on <u>all</u> the step-digit dials. If the setting of the CAD is disturbed (or drifts), the markers and the display response of the device may shift sideways on the scope. The markers, however, are still related correctly to the response of the device.

k. Adjust the FREQ EXCURSION control, which is continuous from ±1 to ±10 CAD major divisions, for a convenient display.

3.4 AUTOMATIC SWEEP.

The triangular, or two-way, sweep output permits the user to observe the effects of the sweep time on the response of the device being tested. If narrow-band devices are swept at a faster rate than the response time will permit, a characteristic "leaning" of the response envelope will be easily detected visually, since forward and reverse traces lean in opposite directions and fail to coincide. The available one-way sweep times range from 20 milliseconds to 60 seconds. This permits an optimum choice of sweep width.

Slow sweep rates are required for narrow-band devices, so that the full amplitude of the response may be reached. A crystal filter, for example, is energized by the source only during the part of the sweep range when the output is within the passband of the device.

Narrow sweep widths and slow sweep speeds are often necessary to permit the signal to remain within the passband for a sufficient response.

NOTE

Too-rapid sweep rates will result in multiple-trace response displays.

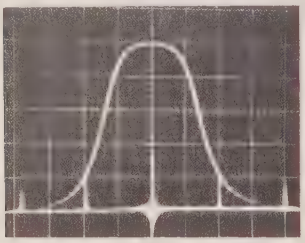
3.5 MANUAL SWEEP.

A manual control of the frequency sweep, and the corresponding deflection-voltage sweep, is incorporated to afford a means of tracing the frequency response with point-by-point control. In addition, closer examination of a critical portion of the response envelope in a demanding application may be attained. The FREQ EXCURSION (sweep-width control) permits the display of varying amounts of frequency coverage on the same scale, about the same selectable center frequency. The horizontal deflection will not change amplitude as this control is adjusted, but the markers will shift to indicate changes in frequency excursion.

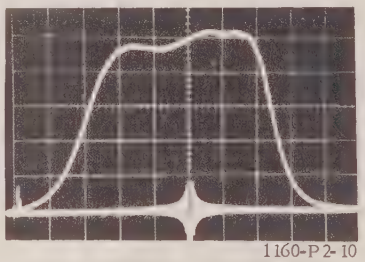
3.6 FREQUENCY-RESPONSE MEASUREMENTS.

Various synthesizer and sweeper combinations can be utilized to perform swept-frequency measurements on tuned networks. Figure 3-1 shows the Type 1162-A7C Synthesizer mounted atop the Type 1160-P2. The controls are set to test the mechanical i-f filter of a communications receiver with a 455-kHz center frequency and a 1.5-kHz bandwidth. The resulting oscillogram is also shown in the figure.

Oscillograms typical of results obtainable with other instrument combinations are shown in Figure 3-2. The level output and constant source impedance of the synthesizer are also important to useful and reliable response testing of crystal and mechanical filters and frequency-selective instruments.



Response of GR Type 1900 Wave Analyzer tuned to 10 kHz and set for 10-Hz bandwidth. Horizontal scale: 5 Hz/cm. Marker frequency: 10,000.00 Hz. The CAD was in the 10-Hz position and was swept ± 2½ major divisions, or ± 25 Hz.



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Response of 50-MHz crystal filter. Horizontal scale: 2 kHz/cm. Marker frequency: 50.00000 MHz. The CAD was in the 10-kHz position and was swept ±1 major division, or ± 10 kHz.

Figure 3-2. Oscillograms showing the frequency response of various filters to the swept output of a synthesizer.

SECTION 4

PRINCIPLES OF OPERATION

4.1 GENERAL.

The functional electrical interrelationship of the Type 1160-P2 as a sweeper accessory to GR synthesizers is shown pictorially in Figure 4-1, as the two units would be combined in a practical measurement set-up.

The adjustable triangular waveform output of the sweeper enters the synthesizer at J104A and is routed to a voltage-tunable oscillator in the CAD module. When the CAD is operated in its EXTERNAL CONTROL mode, the sweep input varies the frequency of this internal free-running oscillator, in adjustable amounts, up to 10 major divisions of the CAD control dial, either side of center frequency.

The resulting swept signal at CAD OUTPUT #1 drives the train of "active" DI units and produces a proportional frequency sweep in the synthesizer OUTPUT. Swept deviations are adjustable from 0.001 Hz to 1 MHz, depending upon the range of the synthesizer with which it is used.

The simultaneous swept signal at CAD OUTPUT #2 is mixed with a 5.0-MHz-plus output, from the train of "replaced" DI-1 units, in the Calibrating Mixer unit, from which two outputs are derived.

One output is routed back to the sweeper via J403A and enters the FROM BEAT terminal, where it in turn is mixed with the reference oscillator and results in the marker output for use with the external display. The second output from the Calibrating Mixer drives a MONITOR METER circuit in the synthesizer, for a separate indication of beat frequency.

A synchronous ±6.0-volt triangular waveform, derived from the adjustable internal sweep of the Type 1160-P2, is available at the SCOPE HORIZ terminal to drive the time base of the oscilloscope used to display the response of the unknown to the output frequency of the synthesizer. The relationship is proportional.

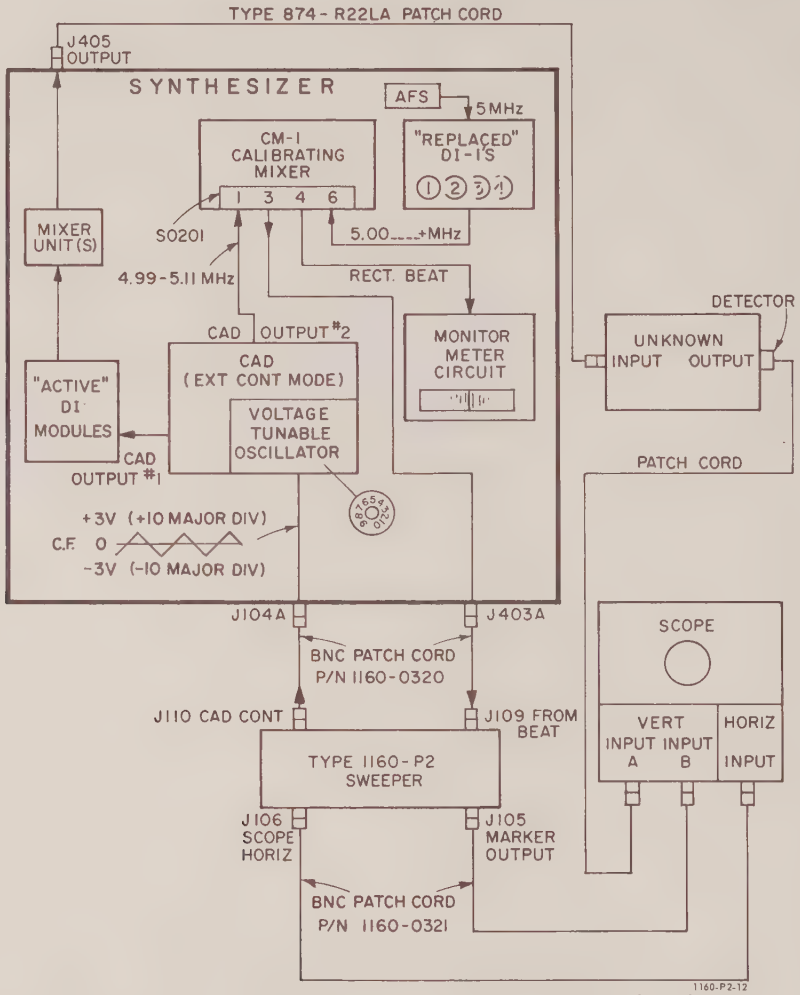


Figure 4-1. Functional circuit interrelationship of sweeper and synthesizer in a typical measurement set-up.

4.2 CIRCUIT DESCRIPTION.

4.2.1 GENERAL.

The Type 1160-P2 Sweep and Marker Generator is a solid-state unit comprised of three sections — a sweep generator, a marker oscillator, and a dc-regulated power supply. Diagrams of the principal components of these sections are given in Figures 4-2 and 4-3, while the over-all detailed circuit schematics appear in Figures 5-3 and 5-5.

The sweep voltage output is obtained from the integration of a step of voltage by an operational amplifier with capacitive feedback. The differential input section is balanced to ground so that either positive or negative inputs are amplified and integrated with polarity retained.

The output of the amplifier is monitored by a level sensor which, at preset positive and negative voltage extremes, causes polarity of the step of voltage applied to the integrator to be inverted. Sweep rates are adjusted by variation of the amplitude of the step and of the integration time of the amplifier. The resulting triangular output voltage is amplitude limited by the level sensor; subsequent buffering and adjustable attenuation result in a controlled-rate variable-amplitude sweep voltage.

The output is also amplified by a stable inverting amplifier to obtain a synchronized horizontal-deflection sweep signal of constant peak-to-peak amplitude for use with an external display.

The reference for the frequency markers generated by the unit is furnished by a Wien-bridge oscillator. The oscillator produces frequencies from 10 kHz to 59 kHz, in 1-kHz increments, with 1% tolerance. These frequencies correspond to 1.0 to 5.9 CAD divisions, in 0.1-CAD-division steps. A thermistor, in a negative-feedback divider in the bridge amplifier, maintains a constant-amplitude marker-reference at all frequencies.

The oscillator output is mixed with the BEAT signal from the synthesizer, and subsequent narrow-band filtering and rectification produces sharp accurate markers.

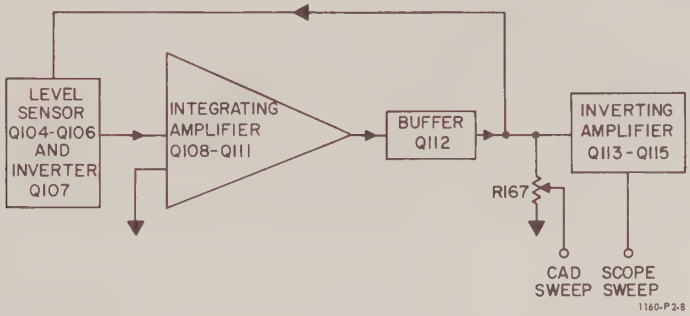


Figure 4-2. Diagram of the sweep generator.

4.2.2 SWEEP GENERATOR (Figure 4-2).

General

The triangular output waveform is furnished by a dc-coupled multi-loop amplifier chain that functions as a reciprocating linear slope generator.

Central to this operation is a long-tailed pair, Q108/Q109, that through application of the Miller effect, presents at its input the appearance of an extremely large capacitance. Acting on this capacitance, the magnified effect of an adjustable network of capacitors in a feedback path, a small step of voltage (also continually present at the input) starts a long-time-constant charge cycle, which is permitted to operate over such a brief period of its possible span that the selected segment constitutes a "linear" slope.

When the input is positive, the sweep is from negative to positive and reverses direction in response to abrupt polarity changes in step-function voltage. The step-reversal process is controlled by the level-sensor circuitry and associated amplifier stages. The capacitive feedback path is routed through Q112, an emitter-follower stage that improves the linearity of the slope and isolates the Miller circuit from the output loads. A portion of the output waveform is sampled by the level sensor so that it can perform its control function.

The resulting frequency excursion in the swept synthesizer is determined by the effect that the setting of potentiometer R167 has on the amplitude of the output waveform.

Level-Sensor and Inverter

The output sweep voltage is monitored continuously by the level-sensor circuit (Q104, Q105, and Q106). This grouping operates like a Schmitt-circuit to reverse the step of voltage at the input of the integrator. The voltage at the base of Q104, determines whether Q105 is conducting or nonconducting. When Q105 begins to conduct, the collector of Q106 switches rapidly between +12 volts and -12 volts.

This voltage is fed back through a voltage divider, R136 and R137, to the base of Q105 in a regenerative manner. Thus, when the input voltage at Q104 reaches +3.3 volts, the base of Q105 switches to -3.3 volts. Conversely, when the voltage at the base of Q104 reaches -3.3 volts, the base of Q105 switches to +3.3 volts. In this manner, the limits of the sweep output are controlled.

Q107 inverts the polarity of the ±12-volt square wave at the collector of Q106, in order to initiate operation of the integrator-amplifier with correct polarity, and thereby maintain synchronism.

Integrator

Stages Q108 through Q112 constitute an integrating operational amplifier with an input end at the base of Q109 and an output at the emitter of Q112. It contains two principal feedback loops, a resistive path

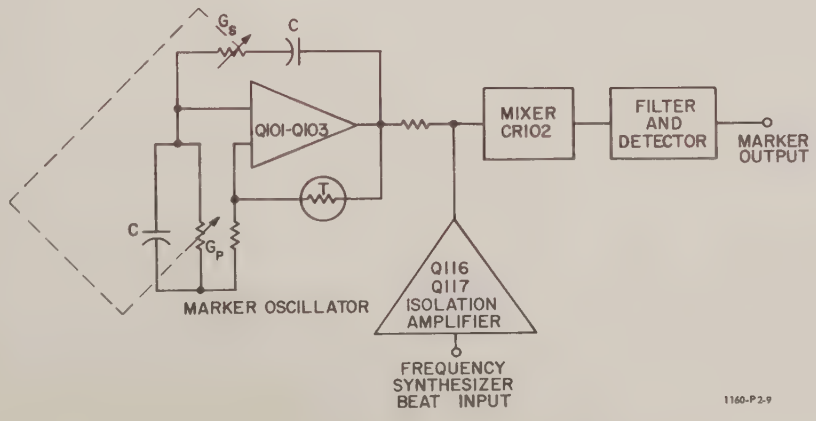


Figure 4-3. Diagram of the marker generator.

through R150 for constant gain, and a capacitive path to furnish the Miller effect needed for the voltage slope.

The dc amplifier consists of Q108, Q109, Q110, and Q111 with a closed-loop gain constrained to equal 200 by negative feedback. Q108 and Q109 are epoxy transistors with their cases epoxied together in an assembly, to minimize thermal drift. Further drift compensation is accomplished by potentiometer R143, a balance control that affects the ultimate symmetry of the output waveform.

Since the waveform excursion must operate about 0 volts, and since the reference at the collector of Q108 is well above that level, stages Q110 and Q111 are utilized to maintain the slope about a 0-volt reference.

The integrating capacitors, C116, C117 and C113-C115, are each used at three sweep speeds selected by S104. A three-position resistive voltage divider, also controlled by S104, determines the sweep time for a given integration constant. The three-position voltage divider, formed by R131, R132, R141, and R142, is used in conjunction with the integrating amplifier to provide sweep-time selection.

For example, a 60-second sweep time is obtained by use of a combined integrating capacitance value of 10 μF and attenuation of the ±12-volt step input, with R141 and R142. A 30-second sweep is obtained with the same integrating capacitor and a larger square-wave input, resulting from the use of R141 and R132, in parallel, plus R142. The linearity achieved is sufficient for proper display of frequency response.

Zener diode CR104 is a 3.9-volt reference in the emitter of Q112 to prevent the current from exceeding specified limits at the operating-supply voltage.

Manual Sweep

The manual sweep output is controlled by potentiometer R156. Both automatic and manual sweeps are buffered by emitter-follower output stage Q112. With SWEEP MODE switch S103 in the OFF position, the output of Q112 is grounded for calibration procedures.

Inverting Amplifier

The dc-amplifier output chain, Q113, Q114, and Q115, is a phase inverter and amplifier (x2) to obtain a synchronized sweep-driving voltage for an oscilloscope display (±6.6-volt).

4.2.3 MARKER-GENERATOR.

The reference oscillator (Q101, Q102, Q103), for generation of frequency markers, is a Wien-bridge configuration. The frequency ($f_o = \frac{1}{2\pi RC}$) is determined by the equality of resistance and capacitance values in the series arm of the bridge with those in the shunt arm. The series arm consists of those switch-mounted parts between AT103 and AT105 plus C102 and C119; the shunt arm consists of those between AT104 and AT110, plus C103 and C120.

Oscillator frequency is controlled by variations of the resistances of the shunt and series arms simultaneously. This is accomplished by the switching of two parallel banks of precision resistors in shunt by means of S101 and S102. S102 selects multiples of unit resistance and the S101 selects tenths.

Q101 and Q103 form the amplifier portion of the oscillator. The closed-loop voltage gain of the amplifier is held constant by the variable negative feedback provided by thermistor R120. The constant-amplitude output is buffered by emitter follower Q101 (for a lower output impedance) and fed to the mixer section through potentiometer R124, which is a marker amplitude adjustment. (An initial square-wave output is obtained from the oscillator, until the thermistor warms up to operating temperature, to give a stable sine-wave output; this takes less than 30 seconds.)

The signal obtained from the BEAT OUT terminal on the synthesizer is mixed with the output of the marker-generator, at diode CR102.

Q116/Q117 constitutes a two-stage buffer amplifier that isolates the marker reference signal from the synthesizer and presents the synthesizer beat signal to the mixer input. The level of BEAT signal at the mixer input should be approximately the same as that at the FROM BEAT terminals.

Diode CR103 is employed to transmit only positive-going side markers to the output (J108) terminal. Subsequent low-pass filtering is performed and the output is rectified by CR103. An alternate signal path, for an unrectified zero-beat input directly from the synthesizer BEAT terminals, is provided by R129 and C112, a low-pass filter. This permits a bipolar marker presentation at the center-frequency output of the synthesizer (i.e., zero beat).

The side-markers deteriorate in amplitude as sweep speed is increased beyond one per second. This is due to the response of the low-pass filter in the marker-mixer output. The center-frequency marker, although distorted somewhat, remains symmetric about its center and is observable at all sweep speeds. Side-marker harmonics produce small additional markers, at twice and three times the selected marker spacing. The primary markers generated by this circuitry are the larger ones nearest the center-frequency reference marker.

The rear wafer of the switch is designed to short the MARKER OUT terminal between positions. This is to avoid display transients when S103 is switched from AUTO to MANUAL.

4.2.4 POWER SUPPLY (Figure 5-5).

The power supply may be used with 100-125-V or 200-250-V, 50-400 Hz, line inputs. Provision for selection of either line voltage is afforded by the slide switch (S402) on the rear apron of the chassis. The dc voltages, which are regulated outputs, are +12 volts and -12 volts. Potentiometer R505 sets the -12-volt output, and R507 the +12-volt output.

The supply contains two short-circuit-proof series regulators that produce and maintain +12 and -12 volt outputs in normal operation, and maintain 1% regulation for line voltages between 100 and 125 V. The reference, located in the negative supply, is a 4.7-volt Zener diode, CR509.

A sample of the negative output voltage is obtained at R505 and compared to the reference in the comparison element, Q504. Initial adjustment of R505 provides the necessary corrective feedback to the negative-supply control element, Q503. Once the negative supply is adjusted, the positive side of the supply can be adjusted using the negative supply as a reference. The adjustment for the positive regulator is R507, which compares a sample of the -12 volt supply against ground in the comparison element, Q502.

The control element of the positive supply, Q501, is supplemented by a preregulator, comprised of R501, R509, CR510, and CR511. The preregulator supplies a constant current to the collector of the dc amplifier, Q502, and the base of Q501. The preregulator minimizes ripple at 120-Vac input and reduces the output impedance of the positive supply.

F501, a 3AG extractor-post unit mounted on the rear apron, protects the primary side of T101 and works for either position of S502.

SECTION 5

SERVICE AND MAINTENANCE

5.1 WARRANTY.

We warrant that each new instrument manufactured and sold by us is free from defects in material and workmanship and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards, after examination by our factory, Sales Engineering Office, or authorized repair agency personnel, will be repaired or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

5.2 SERVICE.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department, giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest Sales Engineering Office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.3 MINIMUM PERFORMANCE STANDARDS.

5.3.1 GENERAL.

Procedures to verify that the Type 1160-P2 sweeper is capable of performing within specification follow; recommended bench test set-ups are given. If the instrument fails to meet minimum-performance standards in the course of these procedures, refer to paragraph 5.4 for possible corrective adjustments and paragraph 5.5 for detail trouble analysis.

5.3.2 TEST EQUIPMENT.

Recommended test equipment, needed to perform these and subsequent procedures, is listed and described in Table 5-1. Equivalent equipments may be substituted.

5.3.3 AUTOMATIC SWEEP.

To check the sweep performance of the AUTO SWEEP mode of the unit, proceed as follows:

a. Install a 2 kΩ 1/2 W resistor across the CAD CONT terminal and connect channel A of the oscilloscope across the resistor (dc coupled).

b. Connect channel B of the oscilloscope across one SCOPE HORIZ terminal (also dc coupled).

c. Apply power to the unit.

d. Set the sweeper controls to:
SWEEP TIME – 0.02
FREQ EXCURSION – Full CCW
SWEEP MODE – AUTO
SIDE MARKER SPACING – Any setting

TABLE 5-1
TEST EQUIPMENT

Function	*Type Recommended*	*Characteristics*
Electronic Voltmeter	1806 (GR)	2% accuracy; ac and dc capabilities.
Oscilloscope	Tektronix Model 543 (with C/A plug-in and P6006 10x passive probe)	20 MHz; 0.5 V/cm with 8 pF (or less) probe capacitance.
Patch Cord	274-NL (GR)	Coaxial with GR274 connectors.
Frequency Meter, Digital	1150(GR)	Range: 10 Hz to 400 kHz.
Oscillator	1309 (GR)	Range: 10 Hz to 100 kHz.
Adaptor, BNC to GR874	874-QBP (GR)	Coaxial, 50-Ω
Dc voltage source adjustable		+4 to -4 V dc, continuous

e. Observe a symmetric triangular waveform sweeping between +0.3 and -0.3 V on channel A and between +6.0 and -6.0 V on channel B. Both patterns should complete their one-way sweep in approximately 20 ms and be 180° out of phase.

f. Change the FREQ EXCURSION setting to fully CW and observe triangular waveforms of +3.0 to -3.0 and +6.0 to -6.0, respectively (minimum). Sweep times should be the same.

g. Repeat steps e and f with the SWEEP TIME control in its .5- and 10-second settings; one-way sweep times should now be 500 ms and 10 s.

5.3.4 MARKER OUTPUT.

To test the marker-generation capability of the sweeper, retain the test set-up of paragraph 5.3.3 and proceed as follows:

a. Connect the output of the test oscillator to the FROM BEAT terminals.

b. Move the channel-A input of the oscilloscope to the MARKER OUT terminal (dc coupled).

c. Move the channel-B input of the oscilloscope to the OUTPUT terminal of the oscillator (ac coupled).

d. Connect the SCOPE HORIZ output of the sweeper to drive the time base of the oscilloscope.

e. Set the SIDE MARKER SPACING control on the sweeper to 1.0 and the SWEEP MODE to OFF. (This corresponds to 0-V SCOPE HORIZ output.)

f. Set the oscillator frequency to 10 kHz (±1%) at 1.3 V, rms, using the oscilloscope across its output terminals (channel B).

g. Disconnect the oscillator briefly to establish the zero reference on the oscilloscope.

h. Reconnect the oscillator and observe a 0.1 V vertical deflection (minimum) on channel A. (Maximize the response by varying the oscillator frequency within ±1% limits, if necessary.)

i. Repeat the check at a SIDE MARKER SPACING control setting of 5.9 and an oscillator setting of 59 kHz.

5.3.5 MANUAL SWEEP.

To check the performance of the MANUAL SWEEP control retain the test set-up of paragraph 5.3.3 and proceed as follows:

a. Set the SWEEP MODE switch at MANUAL.

b. Rotate the MANUAL SWEEP control from fully CCW to fully CW at both limits of the FREQ EXCURSION control.

c. Observe the ±0.3 and ±3.0 V sweep limits on channel A and the ±6.0 V sweep limits on channel B.

5.4 SERVICE ADJUSTMENTS.

5.4.1 GENERAL.

If the Type 1160-P2 sweeper fails procedures of paragraph 5.3: in the case of marginal operation, perform the procedures that follow; in case of total failure or if response to adjustments is inadequate, refer to paragraph 5.5. Test points and secondary controls referred to are shown in Figure 5-1. Reference designators used here are the same as those on the schematic diagrams, Figures 5-3 and 5-5, and in the parts list.

5.4.2 REMOVAL OF CASE.

To perform procedures below it is necessary to remove the case of the instrument. To do this:

a. Release the front-panel screws, accessible through the handles, as appropriate to the mounting methods in use.

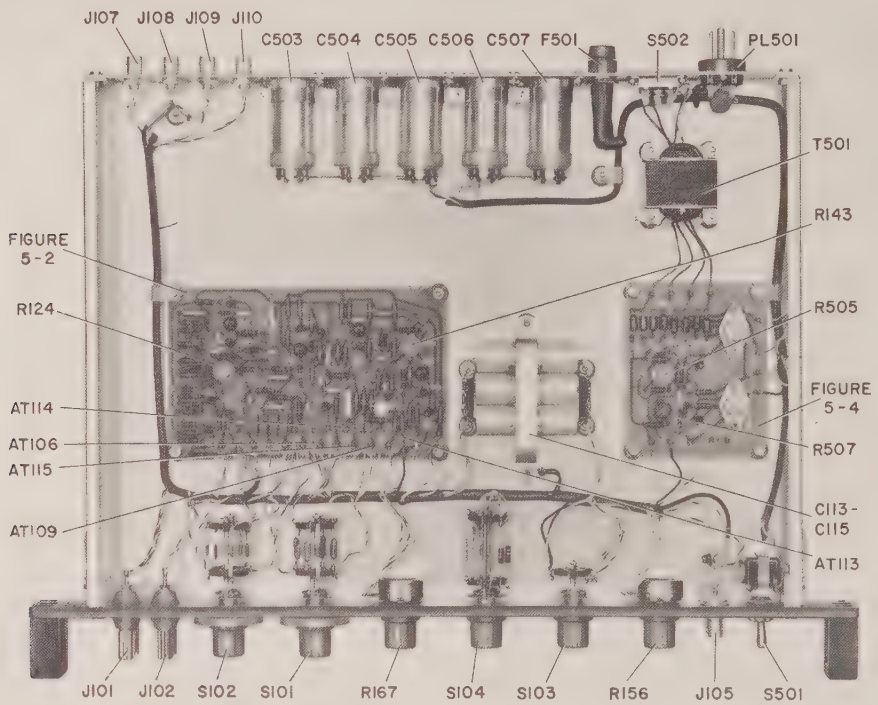


Figure 5-1. Interior view of the Type 1160-P2 sweeper showing test points and secondary controls.

b. Release the two Phillips-head screws at either end of the rear apron.

c. Slide the case (with end frames) off to the rear of the instrument.

5.4.3 ADJUSTMENT PROCEDURES.

DC Amplifier Balance Adjustment. A symmetrical sawtooth output voltage is assured by proper balance of the dc amplifier in the integrator amplifier stage Q108/Q109. To attain proper adjustment:

a. Place the SWEEP MODE switch in the OFF position.

b. Short AT114 (Q109 base), to ground.

c. Adjust DC BAL potentiometer (R143) to obtain 0.5 Vdc at AT115 (Q111 emitter).

R143 is sealed after factory adjustment, so that only unusual temperature conditions or severe jarring of the unit can cause the triangular sweep voltage to "lean" (become unsymmetric) and require readjustment of this control.

Marker-Amplitude Adjustment. The output of the internal Wien-bridge oscillator is mixed with the BEAT signal from the synthesizer. To obtain a proper marker display, use R124 to adjust the level of the internal oscillator signal, present at the junction of R124 and R125, to approximately 1.6 V, rms. This amplitude can be adjusted by potentiometer R124 to obtain 0.1-volt amplitudes (minimum) across the MARKER OUT terminals.

Marker Spacing Adjustment. To check the accuracy of the SIDE MARKER SPACING control settings, connect the digital counter to the test point at the junction of R124 and R125, and vary the settings of the two front-panel switches from 1.0 through 5.9. The marker reference frequencies should be the combined settings multiplied by 10 kHz, ±1%.

Power Supply. The B+ and B- supplies should furnish +12 Vdc and -12 Vdc operating voltages. The voltage-reference diode, CR509, is connected to the emitter of Q504 on the power-supply board; its nominal voltage is 4.7 Vdc. The power supply can be adjusted to obtain -12 volts at AT113 using R505. Subsequent adjustment of R507 should provide a +12-volt regulated output at AT106.

5.5 TROUBLE ANALYSIS.

5.5.1 GENERAL.

The areas of possible malfunction, exclusive of power-supply failure, are in the sweep-generating section and/or the marker-generator section.

5.5.2 SWEEP OUTPUT.

To begin a systematic check of the sweep-generating circuits, observe the dc-balance adjustment as outlined in paragraph 5.4.3. Inability to adjust the voltage at AT115 indicates a faulty component in the integrator-amplifier section. Need for replacement of any or all of transistors Q108, Q109, Q110, or Q111, may be ascertained with switch S103 in the MANUAL position. If no variation of output at J101 (TO CAD CONTROL) is observable, in response to changes in the

setting of the MANUAL SWEEP control, then Q112 should be replaced.

NOTE

A short circuit in S103 could cause 0-Vdc output at the sweep-voltage outputs.

If no automatic sweep output is obtainable and the dc amplifiers are working properly, the level-sensor inverter stage should be checked. To do this unsolder one end of the shorting link joining the emitter of Q112 and the base of Q104. Inject a continuously adjustable dc voltage, at the base of Q104, that varies from +4 to -4 volt limits, to establish proper operating conditions of the level-sensor.

Monitor the dc voltage at the collector of Q106. When the input voltage is raised to +4 Vdc, the voltage at Q106 will change abruptly from +12 to -12 volts and, conversely, when the input is varied from +4 volts to -4 volts, the voltage at Q106 will change to +12 volts. The points of switching are determined by voltage divider R136 and R137 and should be approximately ±3.3 volts.

The voltage at the collector of Q107 should also be monitored (at AT109) and will be equal and opposite to the voltage at Q106. Deviation from this behavior indicates that transistor replacement is required.

Lack of sweep voltage at the J106 (SCOPE HORIZ), when a sweep voltage is present at the CAD CONTROL terminal, indicates that a replacement of the X2 inverter-stage transistors (Q113, Q114, Q115) may be necessary.

Any deviation from normal operation in the sweep-time sequence is probably due to a malfunction of the capacitor switch (S104) or the resistance-divider switch (S104), which determine the nine sweep-time selections. Shorting contacts are likely causes of malfunction.

5.5.3 MARKER OUTPUT.

The internal oscillator in the unit is a Wien-bridge type with amplitude stabilization provided by thermistor R120, in the ac feedback network. The output of the oscillator across R122 should be approximately 2 V, rms, when the oscillator is operating properly. Lack of output may be attributed to a faulty connection on either of switches S101 or S102, or a short-circuited thermistor. An open-circuited thermistor can cause a square-wave output, due to nonlinear operation of the oscillator section.

Once proper operation of the oscillator section is established, the proper level of reference signal should be checked at the mixer, CR102. The signal level should be approximately 1.6 V, rms. Adjustment of this level can be made with R124, with no signal present at the FROM BEAT terminals. Subsequently, the two-stage buffer amplifier (Q116/Q117) should be checked to insure that the BEAT signal from the synthesizer is present at the mixer input; the test point is again the junction of R124 and R125. The level of beat signal at the mixer input should be approximately the same as that at the FROM BEAT terminals.

If the bipolar center-frequency marker is missing or distorted, check the low-pass filter (R129 and C112) in the signal path between the FROM BEAT and the MARKER OUT terminals.

A lack of marker output signals may result if the rear wafer of the SWEEP MODE switch malfunctions. A list of dc operating potentials for the oscillator and buffer-amplifier stages is shown in Table 5-2.

5.5.4 POWER SUPPLY.

The power supply produces +12 and -12 volt regulated outputs in normal operation. The proper dc potentials of the regulator are listed in Table 5-2. Inability to adjust either or both sides, with proper rectified and filtered input, indicates a faulty connection or defective transistor in the power-supply regulator board. Check the reference in the negative supply at CR509, a 4.7-volt Zener diode.

5.6 REPAIRS AND REPLACEMENTS.

If subnormal circuits don't respond to adjustments indicated in the alignment procedures, use the schematic diagrams of Figures 5-3 and 5-5 to localize the trouble area and replace defective detail parts.

The parts list at the end of this section gives pertinent descriptive information on parts used. Reference designators appearing there are the same as those used on schematics and photos. In most cases, the designators are silk-screened on the etched-circuit board to complete the identification. Composite views of the etched boards appear in Figures 5-2 and 5-4.

As an aid to isolate the defective part, Table 5-2 lists dc voltages at transistor leads in all stages of a properly functioning unit. Basing diagrams for the transistor types used are given on the schematic diagrams. The collector lead is identified by a dot on the foil side of the etched-circuit boards.

TABLE 5-2

DC VOLTAGE MEASUREMENTS

Transistor	*Emitter*	*Base*	*Collector*
Q101	-0.5	0	11.0
Q102	1.0	1.6	12.0
Q103	11.5	11.0	2.0
Q116	3.5	4.0	7.4
Q117	3.5	4.0	8.6
Q501	+12.0	12.5	—
Q502	0	0.6	12.5
Q503	0	0.6	—
Q504	-7.7	-7.1	0.60

NOTE:
Voltages measured against chassis ground with Type 1806 direct. Variations of ±10% are to be expected.

PARTS LIST

REF NO	DESCRIPTION	PART NO
	CAPACITORS	
C101	Electrolytic, 15 µF ±20% 20 V	4450-5200
C102	Mica, 0.001 µF ±1% 500 V	4710-0100
C103	Mica, 0.001 µF ±1% 500 V	4710-0100
C104	Electrolytic, 15 µF ±20% 20 V	4450-5200
C105	Ceramic, 1 µF ±20% 25 V	4400-2070
C106	Ceramic, 0.1 µF +80-20% 50 V	4403-4100
C107	Electrolytic, 15 µF ±20% 20 V	4450-5200
C108	Ceramic, 0.0047 µF +80-20% 500 V	4405-2479
C109	Ceramic, 0.02 µF +80-20% 50 V	4402-3200
C110	Ceramic, 2.2 µF ±20% 25 V	4400-2080
C111	Ceramic, 0.001 µF +80-20% 500 V	4404-2109
C112	Ceramic, 0.0022 µF +80-20% 500 V	4404-2229
C113 thru C115	Plastic, 3.3 µF ±10% 100 V	4860-8400
C116	Plastic, 0.464 µF ±2% 100 V	4860-7990
C117	Plastic, 0.0174 µF ±1% 100 V	4860-7845
C118	Electrolytic, 15 µF ±20% 20 V	4450-5200
C119	Mica, 33 pF ±5% 500 V	4700-0301
C120	Mica, 33 pF ±5% 500 V	4700-0301
C121	Ceramic, 0.0047 µF +80-20% 500 V	4405-2479
C122	Ceramic, 0.01 µF +80-20% 500 V	4406-3109
C123	Ceramic, 0.001 µF +80-20% 500 V	4404-2109
C501	Ceramic, 0.0068 µF +80-20% 500 V	4406-2689
C502	Ceramic, 0.01 µF +80-20% 500 V	4406-3109
C503 thru C507	Electrolytic, 600 µF +100-10% 35 V	4450-2400
	RESISTORS	
R101	Film, 30.1 kΩ ±1% 1/8 W	6250-2301
R102	Film, 150 kΩ ±1% 1/8 W	6250-3150
R103	Film, 75 kΩ ±1% 1/4 W	6350-2750
R104	Film, 75 kΩ ±1% 1/4 W	6350-2750
R105	Film, 30.1 kΩ ±1% 1/8 W	6250-2301
R106	Film, 75 kΩ ±1% 1/4 W	6350-2750
R107	Film, 150 kΩ ±1% 1/8 W	6250-3150
R108	Film, 75 kΩ ±1% 1/4 W	6350-2750
R109	Film, 15 kΩ ±1% 1/8 W	6250-2150
R110	Film, 7.5 kΩ ±1% 1/8 W	6250-1750
R111	Film, 7.5 kΩ ±1% 1/8 W	6250-1750
R112	Film, 7.5 kΩ ±1% 1/8 W	6250-1750
R113	Film, 15 kΩ ±1% 1/8 W	6250-2150
R114	Film, 7.5 kΩ ±1% 1/8 W	6250-1750
R115	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R116	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R117	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R118	Composition, 1 kΩ ±5% 1/2 W	6100-2105
R119	Composition, 24 kΩ ±5% 1/2 W	6100-3245
R120	Thermistor, 100 kΩ ±20%	6740-2021
R121	Composition, 4.7 kΩ ±5% 1/2 W	6100-2475
R122	Composition, 1 kΩ ±5% 1/2 W	6100-2105
R123	Composition, 24 kΩ ±5% 1/2 W	6100-3245
R124	Potentiometer, composition, 10 kΩ ±20% 1/2 W	6040-0700
R125	Composition, 15 kΩ ±5% 1/2 W	6100-3155
R126	Composition, 120 kΩ ±5% 1/2 W	6100-4125
R127	Composition, 510 kΩ ±5% 1/2 W	6100-4515
R128	Composition, 390 kΩ ±10% 1/2 W	6100-4399
R129	Composition, 10 MΩ ±5% 1/2 W	6100-6105
R130	Composition, 20 MΩ ±5% 1/2 W	6100-6205
R131	Composition, 47 kΩ ±5% 1/2 W	6100-3475
R132	Composition, 240 kΩ ±5% 1/2 W	6100-4245
R133	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R134	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R135	Composition, 1 kΩ ±5% 1/2 W	6100-2105
R136	Composition, 33 kΩ ±5% 1/2 W	6100-3335

REF NO	DESCRIPTION	PART NO
	RESISTORS (Cont)	
R137	Composition, 82 kΩ ±5% 1/2 W	6100-3825
R138	Composition, 2 kΩ ±5% 1/2 W	6100-2205
R139	Composition, 390 Ω ±5% 1/2 W	6100-1395
R140	Composition, 2 kΩ ±5% 1/2 W	6100-2205
R141	Composition, 240 kΩ ±5% 1/2 W	6100-4245
R142	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245
R143	Potentiometer, composition, 10 kΩ ±20%	6040-0700
R144	Composition, 47 MΩ ±5% 1/2 W	6100-6475
R145	Composition, 100 kΩ ±5% 1/2 W	6100-4105
R146	Composition, 100 kΩ ±5% 1/2 W	6100-4105
R147	Composition, 100 kΩ ±5% 1/2 W	6100-4105
R148	Composition, 180 kΩ ±5% 1/2 W	6100-4185
R149	Composition, 100 Ω ±5% 1/2 W	6100-1105
R150	Composition, 20 MΩ ±5% 1/2 W	6100-6205
R151	Composition, 1.3 kΩ ±5% 1/2 W	6100-2135
R152	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R153	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R154	Composition, 510 Ω ±5% 1/2 W	6100-1515
R155	Composition, 1.1 kΩ ±5% 1/2 W	6100-2115
R156	Potentiometer, composition, 1 kΩ ±10% 1/2 W	6000-0300
R157	Composition, 1.1 kΩ ±5% 1/2 W	6100-2115
R158	Composition, 51 kΩ ±5% 1/2 W	6100-3515
R159	Composition, 39 kΩ ±5% 1/2 W	6100-3395
R160	Composition, 120 kΩ ±5% 1/2 W	6100-4125
R161	Composition, 51 kΩ ±5% 1/2 W	6100-3515
R162	Composition, 100 kΩ ±5% 1/2 W	6100-4105
R163	Composition, 22 kΩ ±5% 1/2 W	6100-3225
R164	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R165	Composition, 1.1 kΩ ±5% 1/2 W	6100-2115
R166	Composition, 100 Ω ±5% 1/2 W	6100-1105
R167	Potentiometer, composition, 10 kΩ ±10% 1/2 W	6000-0600
R168	Composition, 15 kΩ ±5% 1/2 W	6100-3155
R169	Composition, 30 kΩ ±5% 1/2 W	6100-3305
R170	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395
R171	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515
R172	Composition, 15 kΩ ±5% 1/2 W	6100-3155
R173	Composition, 30 kΩ ±5% 1/2 W	6100-3305
R174	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395
R175	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395
R501	Composition, 240 Ω ±5% 1/2 W	6100-1245
R502	Composition, 9.1 kΩ ±5% 1/2 W	6100-2915
R503	Composition, 6.2 kΩ ±5% 1/2 W	6100-2625
R504	Composition, 910 Ω ±5% 1/2 W	6100-1915
R505	Potentiometer, composition, 2.5 kΩ ±20%	6040-0500
R506	Composition, 910 Ω ±5% 1/2 W	6100-1915
R507	Potentiometer, composition, 10 kΩ ±20%	6040-0700
R508	Composition, 6.2 kΩ ±5% 1/2 W	6100-2625
R509	Composition, 300 Ω ±5% 1/2 W	6100-1305
	TRANSISTORS	
Q101	Type 2N3416	8210-1047
Q102	Type 2N3416	8210-1047
Q103	Type 2N3638	8210-1096
Q104	Type 2N3390	8210-1077
Q105	Type 2N3390	8210-1077
Q106	Type 2N3638	8210-1096
Q107	Type 2N1304	8210-1304
Q108	Type 2N3390 Part of 1160-2470	8210-1077
Q109	Type 2N3390 Part of 1160-2470	8210-1077
Q110	Type 2N3638	8210-1096
Q111 thru Q114	Type 2N3390	8210-1077
Q115	Type 2N3638	8210-1096
Q116	Type 2N3416	8210-1047

PARTS LIST (Cont)

REF NO	DESCRIPTION	PART NO
	TRANSISTORS (Cont)	
Q117	Type 2N3416	8210-1047
Q501	Type 40250	8210-1095
Q502	Type 2N3416	8210-1047
Q503	Type 40250	8210-1095
Q504	Type 2N3416	8210-1047
	MISCELLANEOUS	
CR101	DIODE, type 1N645	6082-1016
CR102	DIODE, type 1N3604	6082-1001
CR103	DIODE, type 1N3604	6082-1001
CR104	DIODE, type 1N748A	6083-1002
CR501 thru CR508	DIODE, type 1N3253	6081-1001
CR509	DIODE, type 1N750	6083-1003
CR510	DIODE, type T156	6082-1016
CR511	DIODE, type T156	6082-1016
F501	FUSE, 250 V 0.062 A	5330-0300
J101	JACK, binding post	4060-0410
J102	JACK, binding post	4060-0410
	MISCELLANEOUS (Cont)	
J103	JACK, binding post	4060-1800
J104	JACK, binding post	4060-1800
J105 thru J110	JACK, binding post	4230-2300
——	Knob, control, SIDE MARKER (units)	1160-2860
——	Knob, control, SIDE MARKER (tenths)	1160-2870
——	Knob, control, FREQ EXCURSION	5520-0011
——	Knob, control, MANUAL SWEEP	5520-0011
——	Knob, control, SWEEP TIME	5530-0400
——	Knob, control, SWEEP MODE	5530-0400
PL501	PLUG, power	4240-0600
S101	SWITCH, rotary wafer	7890-4580
S102	SWITCH, rotary wafer	7890-4590
S103	SWITCH, rotary wafer	7890-4600
S104	SWITCH, rotary wafer	7890-4610
S501	SWITCH, toggle, DPST	7910-1300
S502	SWITCH, slide	7910-0831
T501	TRANSFORMER, power	0744-4010

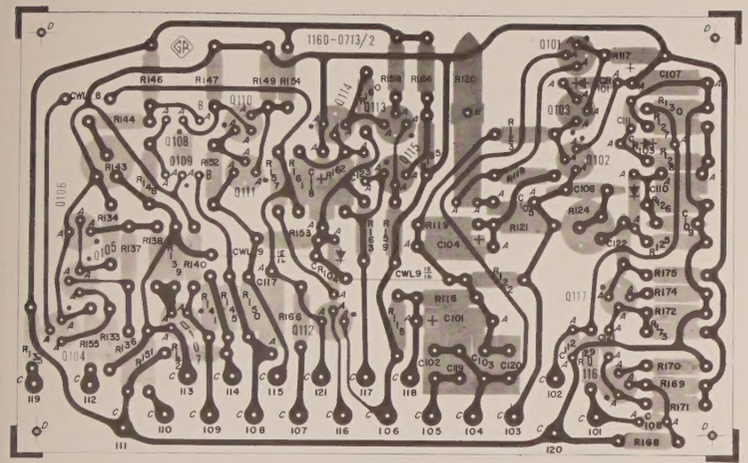
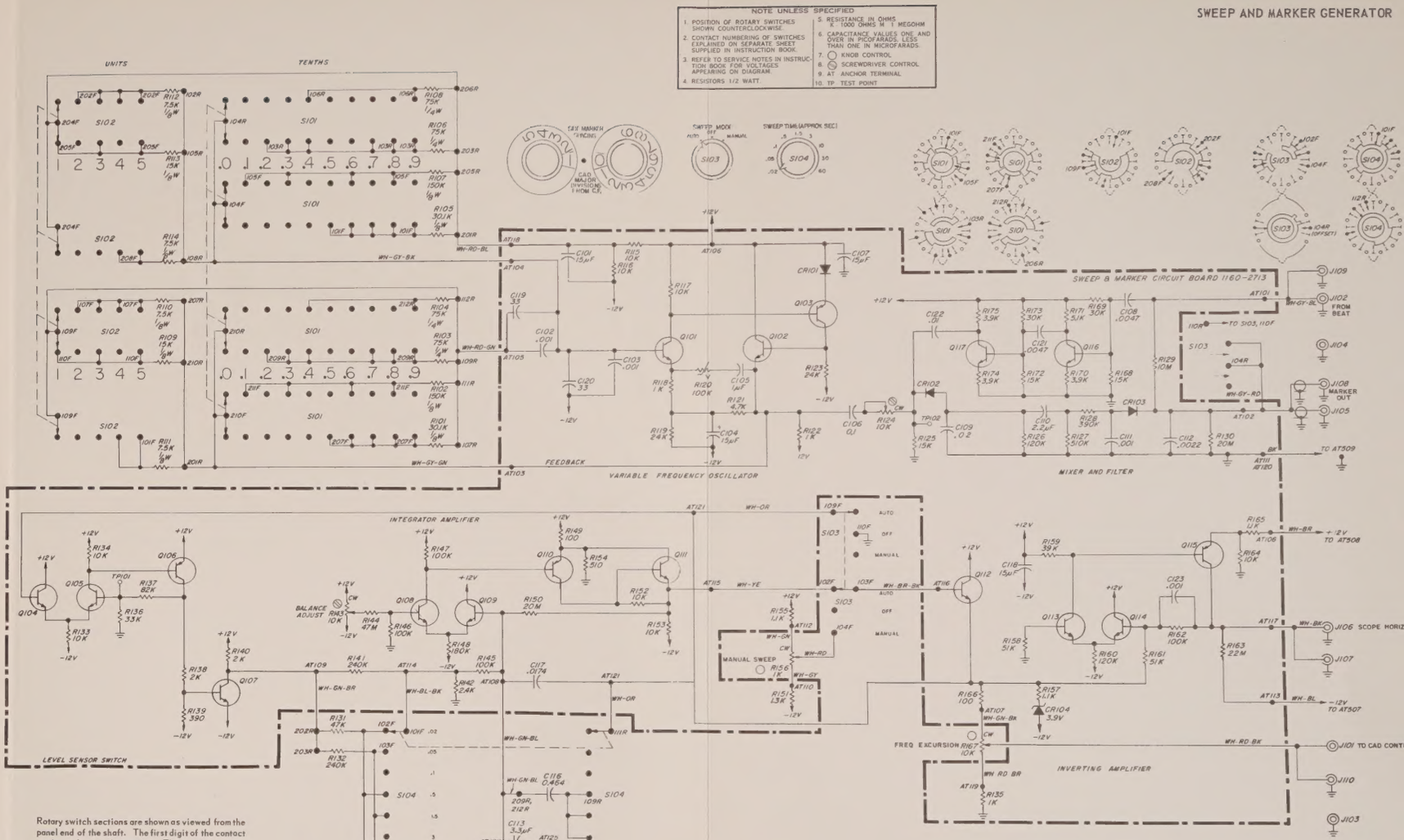


Figure 5-2. Etched-circuit board for the sweeper and marker circuit assembly (P/N 1160-2713).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.


NOTE UNLESS SPECIFIED
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. KNOB CONTROL
8. SCREWDRIVER CONTROL
9. AT ANCHOR TERMINAL
10. TP TEST POINT
UNITS
TENTHS
SWEEP MODE
SWEEP TIME (APPROX SEC)
SWEEP & MARKER CIRCUIT BOARD 1160-2713
VARIABLE FREQUENCY OSCILLATOR
MIXER AND FILTER
INTEGRATOR AMPLIFIER
LEVEL SENSOR SWITCH
INVERTING AMPLIFIER
FEEDBACK
MANUAL SWEEP
FREQ EXCURSION
TO AT509
TO AT508
TO AT507
TO CAD CONT
SCOPE HORIZ

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

Figure 5-3. Over-all schematic diagram for the sweep and marker generator circuits of the Type 1160-P2.

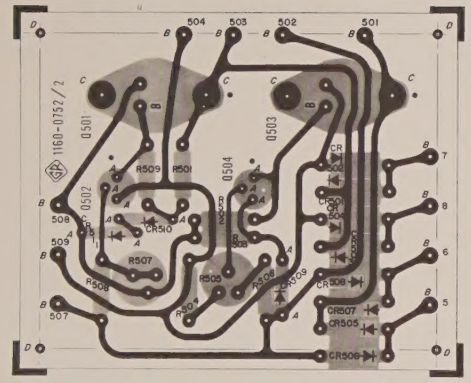


Figure 5-4. Etched-circuit board for the power supply circuit assembly (P/N 1160-2752).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. KNOB CONTROL
8. SCREWDRIVER CONTROL
9. AT = ANCHOR TERMINAL
10. TP = TEST POINT

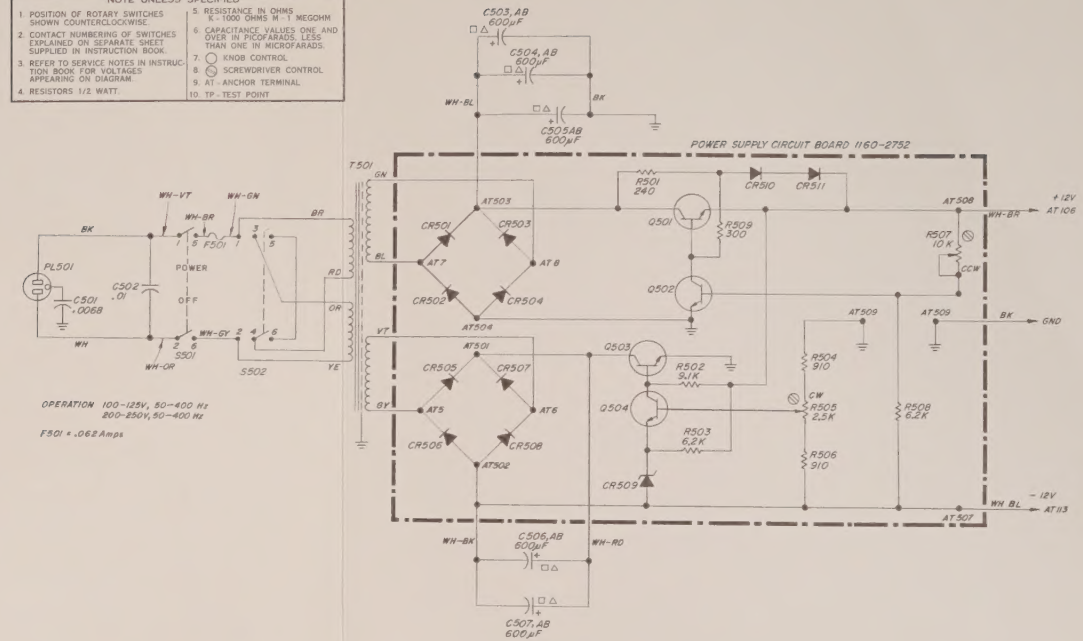


Figure 5-5. Over-all schematic diagram for the power supply circuit of the Type 1160-P2.

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